OUTFALL MONITORING SCIENCE ADVISORY PANEL (OMSAP) MEETING
Tuesday, June 10, 2008, 10:00 AM - 2:00 PM, Ryan Lounge, U. Mass Boston

MEETING SUMMARY

AGENDA TOPICS

- Red tide 2008 update
- MWRA Boston Harbor monitoring results

ATTENDANCE

Members Present: Andy Solow, Woods Hole Oceanographic Institution (chair); Bob Beardsley, WHOI; Bob Kenney, U. Rhode Island; Mike Shiaris, U. Mass Boston; Jim Shine, Harvard School of Public Health; and Juanita Urban-Rich, U. Mass Boston.

Observers: Eric Adams, MIT; Bruce Berman, Save the Harbor/Save the Bay; Jim Blake, ENSR; Mike Bothner, USGS; Todd Callaghan, Mass Coastal Zone Management; Ellie Baptiste Carpenter, Battelle; Ria Convery, MWRA; Kelly Coughlin, MWRA; Mike Delaney, MWRA; Bob Diaz, RJ Diaz & Daughters; Patty Foley, SH/SB; Bernie Gardner, U. Mass Boston; Anne Giblin, Marine Biological Laboratory; Carlton Hunt, Battelle; Mingshun Jiang, U. Mass Boston; Ken Keay, MWRA; Ben Lasley, SH/SB; Wendy Leo, MWRA; Li Li, U. Mass Boston; Scott Libby, Battelle; Matt Liebman, EPA; Jack Looney, U. Mass Boston; Bill Martin, WHOI; Mike Mickelson, MWRA; Ann Michelle Morrison, Exponent/Normandeau; Susan Redlich, Corporate Wetlands Restoration Partnership; Andrea Rex, MWRA; Lev Rozman, Acton Health Department; Larry Schafer, Wastewater Advisory Committee; Jack Schwartz, Mass Division of Marine Fisheries; Chris Sweeney, U. Mass Boston; David Taylor, MWRA; Yong Tian, U. Mass Boston; Cathy Vakalopoulos, MassDEP; Meng Zhou, U. Mass Boston; and Yiwu Zhu, U. Mass Boston.

MEETING SUMMARY

Welcome, Andy Solow, WHOI (chair)

Boston Harbor discussion

Patty Foley, Executive Director of Save the Harbor/Save the Bay and the Public Interest Advisory Committee Chair thanked OMSAP for their hard work over the years. She showed a slideshow of photographs of children and people of all ages enjoying Boston Harbor. Bruce Berman said that Judge Mazzone who presided over the Boston Harbor court case was always interested in measuring the success of the Boston Harbor clean-up and one way to measure it is by looking at the number of people out on the harbor on a hot day. He thanked everyone involved in giving us our harbor back.

Red tide 2008 update

Mike Mickelson (MWRA) compared the *Alexandrium* blooms of 2005-2008 (through May 2008). All blooms have a similar pattern in that they begin in northern Maine waters and spread to the south. The 2005 bloom was the largest bloom since the first red tide in this area in 1972. It was a major regional event in New England made worse in Massachusetts Bay due to prevailing winds and storm patterns. Subsequent blooms have been less intense and widespread. However, so far in 2008, the bloom and shellfish closure patterns have been similar to 2005. No one can predict how severe the bloom will be this year. Last fall, dense cyst beds were mapped and they tend to be found right before large spring *Alexandrium*

blooms. B. Berman asked why the blooms seem to miss Boston Harbor. B. Beardsley is also interested in why some areas are not affected by red tides. D. Taylor thought perhaps the storms that bring the bloom close to shore with northeast winds also bring heavy rains that may flush the bloom out of Boston Harbor. S. Libby said that it's also interesting that Plymouth and Duxbury harbors are not affected by the blooms. This is still being studied by researchers.

MWRA Boston Harbor Monitoring

Timeline for Boston Harbor pollution abatement projects

Andrea Rex (MWRA) described the history of the Boston Harbor clean-up. For more information, go to:
http://www.mwra.com/01news/2008/bhpenvironentalsuccess/bhpenvsuccess.htm
M. Shiaris asked about the plateau in total suspended solids (TSS) from 1998 to 2004. A. Rex replied that the start-up of secondary treatment stabilized TSS discharges. B. Berman asked A. Rex to elaborate on the South Boston CSO project. A. Rex replied that MWRA is building a large storm drain along the South Boston shore that will collect combined sewage and stormwater from seven combined sewer overflows at South Boston beaches. This project will end discharges during less than 50-year storms. B. Beardsley asked about changes in the salinity structure in Boston Harbor. D. Taylor replied that there has been about a 1% increase in salinity which matches what was predicted by the hydrodynamic model. M. Bothner asked about the sludge quality. A. Rex replied that the fertilizer pellets made from the treated sludge are of good quality and are used in agriculture. Metals are low except for seasonal spikes in molybdenum. When this occurs, depending on the concentration, the pellets can either be used in other states, or are landfilled.

Spatial and temporal patterns of sewage indicator bacteria in Boston Harbor and its tributary rivers

Kelly Coughlin (MWRA) described MWRA's bacterial monitoring of 90 stations near CSOs, CSO treatment facility outfalls, beaches, and offshore. Beach sampling is conducted with MassDCR (Department of Conservation and Recreation) and offshore sampling is conducted under agreement with Mass Fisheries. For more information go to:
http://www.mwra.state.ma.us/harbor/enquad/pdf/2008-07.pdf
B. Berman noted that there was a change in the bacteria being measured (fecal coliform vs. *Enterococcus*). K. Coughlin said that EPA believes *Enterococcus* is a better indicator of illness but it's not as abundant as fecal coliform. However, MWRA has done comparison testing and the two are comparable. B. Berman asked about the questionable data from Fort Point Channel. K. Coughlin replied that those were *E. coli* data. They are still analyzing that data, and are measuring fecal coliform there now. A. Solow asked how many samples per day are taken at Wollaston Beach. K. Coughlin replied four per day. B. Berman pointed out that it's usually the center two stations that have exceedances. He thinks that the four stations should be considered separately but if two or more stations exceed, then close the entire beach. C. Hunt asked if they have looked at rainfall events to see if there is a threshold that triggers a posting. K. Coughlin replied that they have looked at this but there is no threshold that is accurate all of the time. M. Shiaris asked if there have been exceedances in Massachusetts Bay over the outfall risers. K. Coughlin replied that there have been a few due to disruptions of treatment at the plant. L. Rozman asked what other statistical approaches have been used to examine the trends. K. Coughlin replied that they have done regression models and nonparametric work. This will be discussed in the next presentation.

Bayesian modeling for beach management at Boston Harbor beaches

Ann Michelle Morrison (Exponent/Normandeau) described Bayesian networks which are models that compare possible states of reality with probability. The name Bayesian comes from the name of this person that developed this modeling, Rev. Thomas Bayes. It is based on conditional probability – where everything is related. This modeling is used to better predict beach closures since there isn't a strong relationship between yesterday's sampling and today's postings. Bayesian networks are generally designed to follow causal linkages. She showed the Bayesian network for Constitution Beach which is used to help determine the probability of exceeding *Enterococcus*. A beach manager could input weather and sampling data to help make a decision. Data in the network include: winds, tides, precipitation, water temperature, salinity, sunlight, currents, and prior probability. She then showed a comparison of management models for Constitution, Wollaston, Tenean, and Carson beaches. The Bayesian networks for all of the beaches except for Carson worked as well or better than a rainfall only management model. Carson Beach is the cleanest and so an exceedance is not always related to rainfall therefore the Bayesian network did not work well there. Instead, 48-hour rainfall thresholds are the most protective, but they often close a clean beach. One important thing to note is that local rain gauges are very important. Using data from Logan isn't as accurate. M. Shiaris said that he has a graduate student sampling at Wollaston Beach. The sands are very high in *Enterococcus* and could be a reservoir. He asked if this is considered in the model. A. Morrison replied no, but perhaps this could be added, along with other meteorological information. She also thinks the water table may be pushing dirty water out of crumbling storm drains. M. Liebman asked if the Bayesian networks show 1-2 factors that contribute to closures the most. A. Morrison replied that this could be determined by doing a sensitivity analysis.

Changes in productivity in Boston Harbor

Scott Libby (Battelle) reviewed the harbor and outfall water quality and productivity sampling programs. There are three productivity stations, F23 is in the outer harbor and N04 and N18 are in the nearfield. He presented monitoring results. For more information go to: http://www.mwra.state.ma.us/harbor/enquad/pdf/2009-04.pdf

Overall, there have been large decreases in peak productivity on a seasonal basis in Boston Harbor. Summer peak productivity has decreased by 56% and annual production has decreased by >40% since the outfall diversion. However, production in the nearfield has also decreased and this is largely due to a reduction in the annual fall bloom. These results show that the outfall diversion has resulted in significant improvements in water quality in Boston Harbor. Though the decrease in nutrient loading was certainly a factor, annual production has been lower at all three stations since 2002 and this may be due to regional changes that are masking changes due to the outfall diversion. Ongoing analyses are focusing on winds and stratification. Preliminary results suggest a correlation between strong winds, less stratification, and higher productivity on a seasonal and annual basis. M. Liebman asked about water clarity. S. Libby replied that there is a disconnect between productivity, particulate organic carbon, and chlorophyll. They will be examining clarity further.

Long-term patterns in sediment contaminants in Boston Harbor

William Martin (WHOI) described the processes influencing the long term fate of contaminant metals in Boston Harbor. He described results from monitoring in Hingham Bay from 2000 to 2008. He showed how concentrations of mercury, lead, and copper have decreased significantly in the surface sediments since 1980. He noted that organisms mix the sediments, bringing older contamination closer to the surface. These three metals are associated with organic material and can form stable complexes that may be trapped in the sediments. They can also co-precipitate/sorb to iron oxides potentially removing these metals

from pore waters. He then showed sampling and resuspension experiment results. It appears that the remobilization of contaminant metals deposited is the past may now be a significant source of metals to Boston Harbor. Further work includes updating and extending contaminant metal budgets for Boston Harbor, and determining the distributions of particulate metals in Massachusetts Bay, especially after significant resuspension events.

Changes in spatial patterns in harbor sediment contaminants

Carlton Hunt (Battelle) described the results of a study of contaminants in Boston Harbor from 1990 to 2000 undertaken as part of the 1997 CSO Control Plan. He began by describing the combined sewer system in Boston, Cambridge, Somerville, and Chelsea that collects and transports both sewage and stormwater to the Deer Island Treatment Plant. During heavy rains, this system discharges contaminated water into local waters. The 1997 CSO Control Plan was developed to improve the CSO system performance and reduce these discharges. As of 2006, 19 or 35 proposed projects were completed. The remaining projects are expected to be completed by 2015. For more information on CSOs, go to: http://www.mwra.state.ma.us/03sewer/html/sewcso.htm. He then described the harbor sediment contaminant study. A recent report on contaminants is located at: http://www.mwra.state.ma.us/harbor/enquad/pdf/2006-23.pdf.

Changes in nutrient flux and sediment oxygen demand in harbor sediments

Anne Giblin (Woods Hole Marine Biological Laboratory) gave an overview of benthic nutrient cycling in Boston Harbor. The sampling program monitors two stations in northern Boston Harbor (BH03 at the former sludge dumping site, and BH02 which is a heavily reworked site), one in Quincy Bay (QB01), and one in Hingham Bay (BH08A). Total organic carbon (TOC) decreased at all stations but most significantly at the former sludge disposal site. There has been a slight increase in sediment chlorophyll *a* in the spring and fall but it is not statistically significant. In 2007, the sediment oxygen demand (SOD) was lower than the range before the outfall was diverted and is comparable to other post-relocation years. Overall, they have seen a large decrease in variability from storms and amphipods. In 2007, BH02 had higher SOD and nutrient flux concentrations, consistent with the presence of amphipod mats. The *Eh* profiler did not show strong reducing conditions near the surface. When presenting denitrification data, she noted that changes in patterns may be due to changes in laboratories and techniques. She then described changes in nitrogen export, denitrification, and burial in the harbor over time. Overall, loading to the harbor has been reduced by 81%. Though denitrification appears to have decreased in Boston Harbor since the outfall was relocated, its significance has a nitrogen sink in the harbor total nitrogen budget has increased due to the decrease in loading. In a comparison of nitrogen-impacted estuaries around the country, Boston Harbor in 1995 had the highest SOD and now it is among the lowest, along with Mass Bay. The outfall relocation has not affected Mass Bay's productivity. For more information go to: http://www.mwra.state.ma.us/harbor/enquad/pdf/2008-14.pdf . M. Shiaris thought that was good news about the denitrification. He asked what happens when there is more oxygen in the sediments. A. Giblin replied that denitrification works best when there is a good aerobic zone. J. Shine asked how important it is to correct for temperature differences when the various estuaries are compared. A. Giblin replied that the sediments can only metabolize what hits the bottom. So carbon loading drives the process and temperature is more of an issue when comparing seasons.

Rapid assessment measures of sediment habitat quality; changes over time

Bob Diaz (Diaz and Daughters/ENSR) presented an assessment of changes in Boston Harbor's sediment habitat quality over time. From 1992 to 2007, there was a greater than

90% reduction in carbon loading, with lower phytoplankton and nutrient concentrations. With these improvements, benthic habitats shifted from anaerobic to a more aerobic state and there were also shifts in infaunal trophic structure. Though sediment profile imaging still shows a gradient in the RPD (redox potential discontinuity, i.e. how far oxygen penetrates into the sediments) from shallow to deeper as you move from the inner to outer harbor, improvements of RPD have been measured at individual stations. Though *Ampelisca* spp. tube mats dominated in the mid to late 1990's, they have declined along with decreasing amounts of carbon. Microalgal mats are now more common, along with deeper, more bioturbating species. For more information, go to: http://www.mwra.state.ma.us/harbor/enquad/pdf/2008-22.pdf. M. Bothner asked about food sources for flounder and lobster. B. Diaz replied that the amphipods were a great source of food for young flounder. Now that amphipods have declined and the trophic structure is more complex, he suspects there is less food for them. B. Berman added that flounder are also affected by fishing pressure.

Spatial and temporal changes in Boston Harbor's benthic community

Jim Blake (ENSR) described benthic monitoring plan in Boston Harbor. Initial surveys were conducted by the Metropolitan District Commission (MDC) as part of their 301(h) waiver applications in 1978, 1979, and 1982. MWRA began its annual sampling in 1991. He then described the milestones of the Boston Harbor Clean-up and how the benthic monitoring plan is designed. He showed changes over time in faunal abundance, species richness, and diversity over time. He then discussed the composition of the benthic community including the abundances of *Ampelisca* spp. over time. He then focused on the Deer Island Flats station (T01) which has shown significant improvements in species diversity as well as a complete change in community structure. Though the abundances have decreased over time at station T01, the diversity has increased and this corresponds to the harbor-wide decline in *Ampelisca* spp. Overall, benthic communities in Boston Harbor have improved significantly since the diversion to the new outfall and there is no evidence of any adverse impacts on the infaunal benthos of Massachusetts or Cape Cod Bays since the new outfall came on-line. For more information go to: http://www.mwra.state.ma.us/harbor/enquad/pdf/2008-22.pdf.

J. Shine asked if this is an example of the intermediate stress theory and whether diversity increase as the harbor stabilizes. J. Blake replied that though there have been increases in the number of species in the harbor, things have slowed down. The "new" species in the harbor are all from Mass Bay and there isn't evidence that these species are taking hold. He thinks things have stabilized and the species in the harbor now will remain into the future. However, since the Deer Island Flats and Presidents Roads stations have undergone such a dramatic change, he doesn't know what the final community will look like. B. Berman noted that there are different communities at different locations at different times. J. Blake said that there is a definite seasonality in the benthos and different species dominate from season to season. They sample in August which is the peak of benthic productivity.

ADJOURNED

Summary prepared by C. Vakalopoulos.